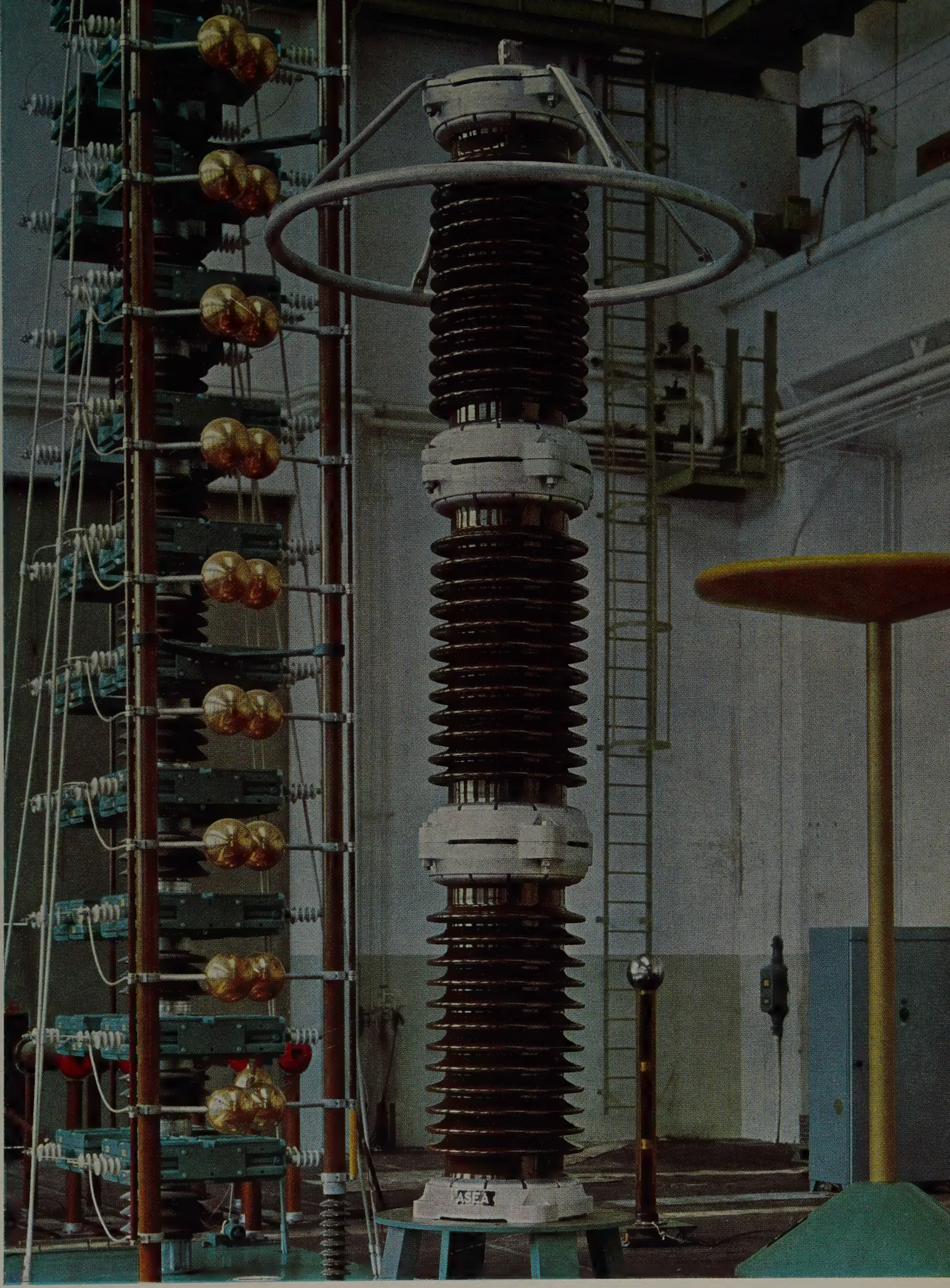

Asea's new active-gap lightning arrester, voltage rating 265 kV, being tested in the High-Voltage Laboratory at Ludvika. In the background, the new surge generator for 3.2 MV, 140 kWs. (F 929)

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NEW HOLDING FURNACE

A continuous and intensive development programme, making full use of experience from production conditions, has been pursued by ASEA with the aim of producing suitable electric furnaces for the holding of molten iron in foundries.

Holding furnaces of this nature are required both as an intermediate link between the pure melting furnaces and the casting stations, and as a magazine of molten iron for very large castings.

The photograph shows a mains-frequency induction holding furnace being tapped. It consists of a horizontal cylindrical body, fitted with inductor units incorporating channels, where the molten metal forms short-circuited transformer turns. The revolutionary feature of these ASEA furnaces i that the inductor units can be rapidly and simpl replaced without having to tap the furnace. Wit three inductor units having a total rating of 45 kW, the temperature of the molten metal can b raised 50°C per hour, when the furnace is full charged with 15 tons.

By installing this type of furnace in your foundr you will be able to rationalise its production i an effective manner.

ASEA

CTIVE-GAP LIGHTNING ARRESTERS

rent W. Greve, Department for Over-voltage Protection, Västerås

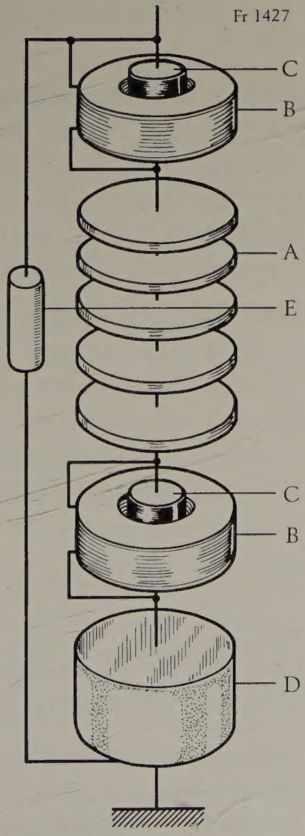
U.D.C. 621.316.933.6.064.44
Asea Reg. 5680

summary of the most important developments in the eld of lightning arresters during the last few years, llowed by a description of Asea's new active-gap ghtning arrester.

ISCHARGE VOLTAGE AND SURGE WITHSTAND TRENGTH

he technical development of lightning arresters which as taken place during recent years, has resulted above l in improvements regarding the data for the discharge ltage and the low-current, long-duration withstand rength.

he protective level of an arrester is determined by the arkover voltage and the discharge voltage. Because the scharge voltage for a discharge current corresponding the arrester class (10 kA for the arresters concerned ere) normally is higher than the sparkover voltage at rge 1/50, the protective level will be determined in most cases by the discharge voltage. A decrease in the discharge voltage will therefore result in an increase in the safety margin between the protective level of the arrester and the basic insulation level of the plant.

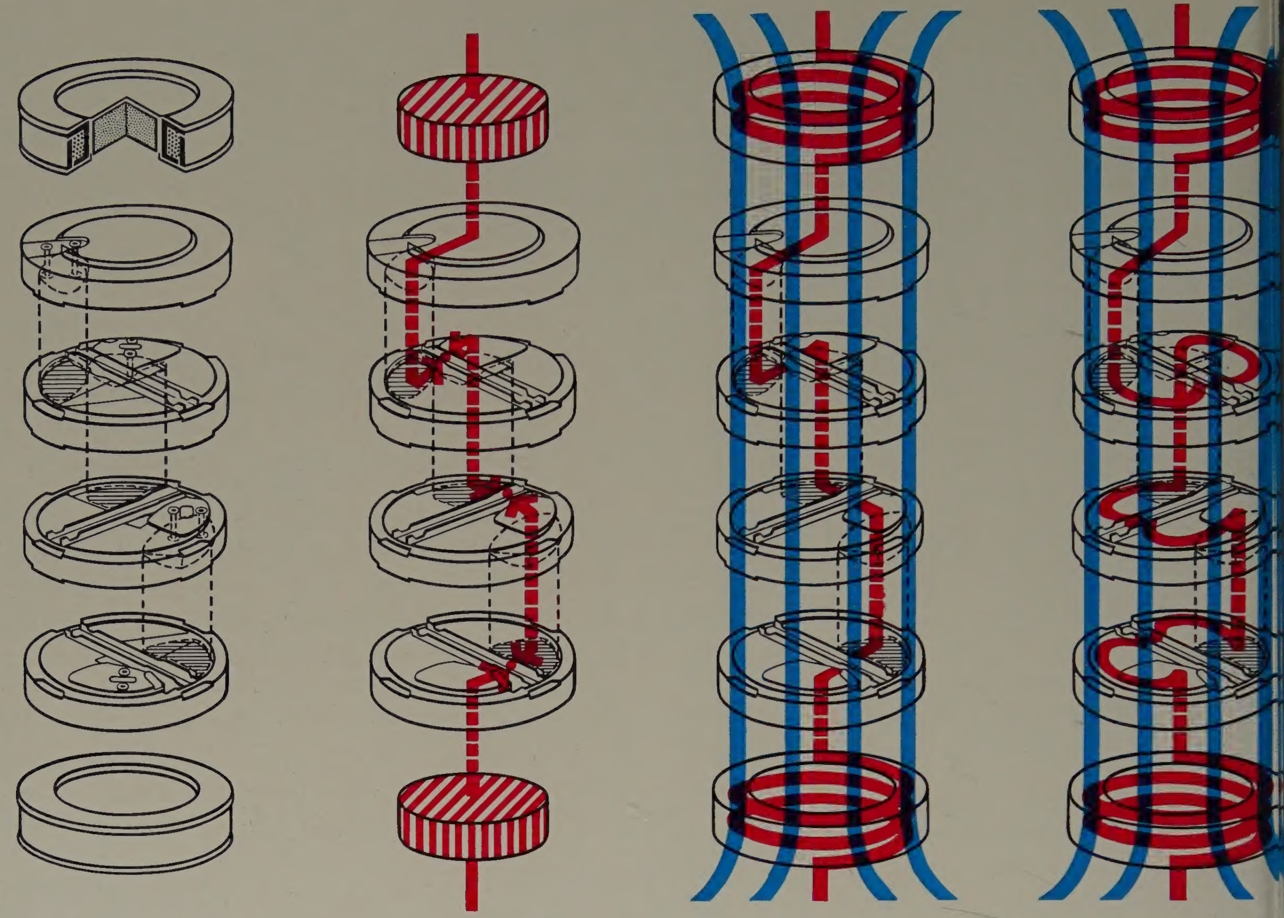


Stack of spark gaps
Coil
Shunt resistor
Valve resistor
Grading resistor

g. 1. One section of an active-gap arrester.

The discharge voltage can be reduced by utilising valve resistors having a greater conductivity at high discharge currents. The main task of the valve resistors, however, is to limit the follow current to such a low value as to enable the spark gaps to extinguish the arc at the first zero passage of the a.c. voltage. One method of reducing the discharge voltage would therefore be to utilise valve resistors having a higher exponent in the high-current range. However, for valve resistors made of silicon carbide with binding materials, the possibilities of such an increase in the exponent seem to be almost exhausted. The reduction of the discharge voltage, which has been obtained by several manufacturers during recent years, has mainly been achieved by utilising spark gaps having better reseal properties. Whereas some years ago the spark gaps usually could extinguish follow currents of about 50 A, modern spark gaps of conventional design are able to interrupt follow currents of 200–300 A and even more. Such spark gaps permit the application of valve resistors having a comparatively high conductivity, and the discharge voltage becomes low.

The second great improvement is the increase in the withstand strength against surges of long duration. Such surges are obtained when discharging the capacitive energy of long overhead transmission lines, extensive cable systems and capacitor banks. If an arrester sparks over in conjunction with surges of this kind, the valve resistors will be exposed to severe thermal stresses. For this reason, most standards for valve-type lightning arresters contain certain requirements regarding the low-current, long-duration withstand strength of the arresters. It is usually stipulated that the arresters must be able to withstand 20 surges of rectangular waveshape, each surge having a duration of 2,000 μs, and a current of 150 A. Modern heavy-duty lightning arresters normally comply with this requirement without any difficulty. In many cases, however, a considerably higher discharge capacity is needed, especially if the sparkover voltage of the arrester at low frequencies is so low that there is a great probability of sparkover during switching surges.



a) Sparks gaps, shunt resistors and coils

b) The surge current is discharged to earth via shunt resistors and sparks gaps

c) The follow current finds its way into the coils and creates a magnetic field

d) The magnetic field blows out the arc

Fig. 2. Principle of operation. (Fr 1428)

It should be borne in mind, however, that the magnitude of the discharge current to some extent is determined by the characteristics of the arrester itself. Laboratory tests, where long surges with comparatively high currents are forced through an arrester, do not therefore give a complete picture of the service reliability of the arrester when exposed to switching surges.

THE ACTIVE-GAP LIGHTNING ARRESTER

During recent years, the requirements regarding the quality of lightning arresters have become more and more severe. High transmission voltages (220–400 kV) are becoming more common, and the lengths of the transmission lines are steadily increasing. At the same time, there is a tendency to decrease the ratio between the impulse level and the service voltage. All these factors impose stricter requirements on the lightning arresters.

Asea have been working for several years on the development of a new arrester for high voltages. The aim has been to design an arrester which could combine excellent protective qualities with a high degree of se
vice reliability. The new arrester, which carries the ty
designation XAL, is now available on the market. Cor
prehensive research work has led to the new desig
which in every detail bears the imprint of Asea's gre
experience with lightning arresters for high voltages.

The operation of the new arrester is based on the app
cation of magnetic spark gaps, and the arrester diffe
therefore fundamentally from those of conventional d
sign. The active-gap arrester is made up of several serie
connected sections. Each section has a rated voltage
6 kV, and the number of sections in a complete arrest
is therefore proportional to the rated voltage of the a
rester. The assembly of the sections is shown schematical
in Fig. 1. The spark-gap stack A is terminated at bo
ends by a coil B, in the middle of which is placed
shunt resistor C. Each section has a valve resistor blo
D and a shunt-connected grading resistor E.

When the arrester sparks over due to a voltage surg
the initial current path is made up by the shunt resisto
the spark gaps and the valve resistor (Fig. 2b). The ar
across the spark gaps are very short at the beginnin

ıd the arc voltage is therefore low. The voltage drop ross the section will consequently be practically equal the sum of the voltage drops across the shunt resistors ıd the valve resistor. The steepness of the discharge ırrent will be so high that only a very small part of e current will pass through the coils because of their gh reactance.

/hen the main part of the surge current has been disıarged, the follow current from the network remains. he latter is of very long duration compared to the surge ırrent. A large part of the follow current will therefore ıss through the coils and create a strong magnetic field right angles to the arcs between the spark-gap elecodes (Fig. 2c). Under the influence of this magnetic eld, the arcs are blown out so that their initial length increased by 50 to 100 times; at the same time they e forced to leave their points of ignition (Fig. 2d). ecause of this the voltage drop across the spark gaps creases considerably, and when the arcs have reached ıeir ultimate length, the voltage drop across the spark ıps constitutes a major part of the total voltage drop ross the section. In this way, the follow current is fectively quenched by the spark gaps, whereas in a ghtning arrester of conventional design the follow curent is limited by the valve resistors alone. The new ctive-gap arresters have therefore a remarkable breakg capacity unlike conventional arresters; they exnguish the follow current noticeably before the zero ıssage of the a.c. voltage.

ɔark gaps, valve resistors, grading resistors

he spark gaps are formed between electrodes which e riveted to circular discs. The discs are moulded with gh precision from glass-bonded mica and have excellent ıermal and mechanical properties. They fit tightly ound the outer rim, whereas the central part of each sc is made thinner so that a slot is created between ljacent discs. Electrodes are arranged in each slot in ıch a way that two series-connected spark gaps are rmed between them. When sparkover has occurred, e arcs are forced towards the pheriphery, where the ot width is less than at the ignition points, thus facilitting arc extinction.

a lightning arrester of conventional design it is the lve resistors that limit the follow current to such a w value that the spark gaps are able to extinguish the c. As mentioned above, in the active-gap arrester the llow current is limited to a great extent by the spark ıps themselves, thus relieving the burden on the valve sistors. These arresters can therefore be made with lve blocks having a higher conductivity than those of nventional arresters, and the active-gap arresters have

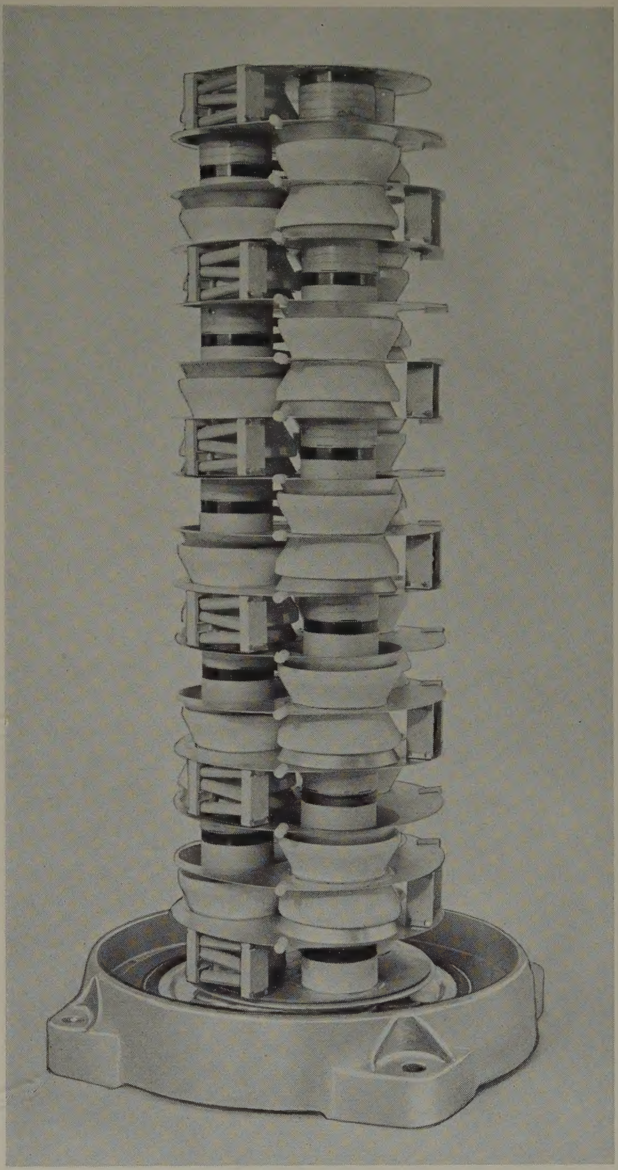


Fig. 3. Arrangement of internal parts of an active-gap arrester. (56884)

for this reason a remarkably low discharge voltage. The discharge factor – the ratio between the discharge voltage crest value) and the rated voltage (R.M.S. value) – is 2.4 at 5 kA and 2.6 at 10 kA. At the same time, the valve resistors have a high withstand strength against long surges; the arrester will withstand 20 surges of rectangular wave-shape, of 2,000 μs duration, and with a current of 800 A. The high surge withstand strength of the arresters is of major importance to the service reliability of the arresters when exposed to discharges of long transmission lines, cables and capacitor banks.

Each section is shunted by grading resistors, whose purpose is to achieve a linear distribution of the a.c. voltage along the entire arrester. The grading resistors utilised in the active-gap arresters have a non-linear currentvoltage characteristic, which is a great advantage if the

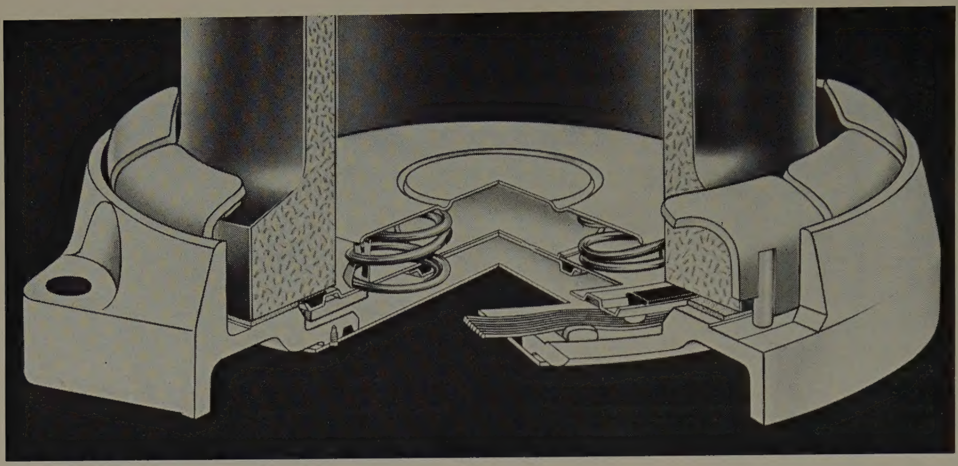


Fig. 4. Exploded view
the bottom of a section
an active-gap arrester sho
ing the method of fixi
and sealing adopted.
(Z 12353)

arresters are to be used in polluted areas. Deposits of dirt or salt on the porcelain housing of an arrester may considerably increase the leakage current, especially in humid weather. The conditions may be aggravated if the conductivity of the pollution layer is uneven, since this may distort the voltage distribution in the interior of the arrester and decrease the sparkover voltage at power frequency and at switching surges. There will then be a risk of repeated sparkovers of the arrester due to overvoltages which in themselves are harmless, and such sparkovers may severely threaten the service reliability of the arresters. The nonlinear grading resistors greatly reduce the drop in the sparkover voltage in the event of pollution and thus help to ensure a high service reliability of the arresters under adverse conditions.

For voltage ratings above 120 kV the arresters are equipped with grading rings for additional control of the impulse voltage distribution across the arrester.

Assembly

The individual sections are arranged in three stacks, which are interconnected by means of a zig-zag arrangement similar to that used for arresters of types XAB and XAC. In this way a robust design of remarkably low height is obtained. The sections are secured between profiled sheet steel, see Fig. 3, and rest in porcelain cups, thus achieving a sufficient mechanical rigidity. The three stacks, enclosed in a common porcelain housing, constitute one arrester unit. The complete arrester is built up of such units, the number and size of which are determined by the voltage rating of the arrester. Each unit is hermetically sealed and filled with dry nitrogen.

The flanges are fixed to the porcelain housing by means of spring clamps resting on cork bedding. This ensures a uniform distribution of the mechanical stresses which may occur in conjunction with vibrations, changes in temperature, etc. Such stresses can in no way influence the sealing, which is not impaired by sma movements between the porcelain housing and tl flanges. Fig. 4 shows the arrangement of the sealin method adopted. The arrester units are fitted with cov plates at both ends. A soft rubber gasket lies betwee the cover plate and the ground porcelain surface. Tl cover plate is pressed with great force against the po celain by means of a gasket spring. This method ha been utilised by Asea for many years and has proved possess excellent sealing properties.

The arresters are fitted with a pressure-relief devic which operates if the arrester should fail to reseal, i. carry a persistent short-circuit current. A pressur relief diaphragm is arranged in the middle of the se plate, as shown in Fig. 4. The diaphragm will be blow out with great force if the internal over-pressure excee 6 atm, and the external cover plate will then be torn o immediately. The gas will escape through the spaciou openings in the flanges.

The arresters are mounted on two horizontal chann irons supplied together with the arresters. The activ gap arresters are mainly intended for high service vol ages where it is customary to use counters connecte to the arresters. The channel irons are insulated fron the bottom flange of the arrester, and surge counters ca therefore be directly connected to the bottom termina

Technical data

Arresters of type XAL have the following technical dat (expressed in terms of the rated voltage U_r):

Sparkover voltage at power frequency and at switching surges	min. 1.6 U_r
Impulse sparkover voltage, surge 1/50 (50 per cent value)	2.25 U_r (±10 %
Front-of-wave impulse sparkover voltage according to I.E.C.	3.0 U_r (±10 %)

ischarge voltage at 5 kA, irge 10/20	max. 2.4 U_r
ischarge voltage at 10 kA, irge 10/20	max. 2.6 U_r
npulse-current withstand strength:	
2 surges, wave-shape 5/10	100 kA
20 surges of rectangular wave-shape and of 2,000 μs duration	800 A

he factor of the impulse sparkover voltage at surge /50 is given as a 50 per cent value, i.e., at this voltage here will be a 50 per cent probability of sparkover of e arrester. The maximum value may reach 15 per cent bove the average value.

he front-of-wave impulse sparkover voltage is given r a front steepness as defined in the I.E.C. Standards. these the front steepness of the surges is limited to ,200 kV/μs.

ields of application

he new active-gap arresters, type XAL, are mainly tended for the highest system voltages, where they eplace the older type XAB. Also for the voltage range 00–300 kV the XAL arresters may be used sometimes ith advantage instead of type XAC. This is mainly the ase where it is possible to benefit from the excellent rotective level of the arresters by reducing the insution level of the plant, or where it is desirable to have particularly high withstand strength against longuration switching surges caused by large capacitances cable networks or long-distance transmission lines).

he XAL arresters will only be used in exceptional cases r the voltage range 100–200 kV. For this voltage range rresters of type XAA, which are cheaper than type AL, can generally provide adequate protection and igh service reliability. Under certain conditions, when rresters of very low height are required or when xtensive cable networks are connected to the system, may be advantageous to select arresters of type XAL r voltage ratings down to 100 kV.

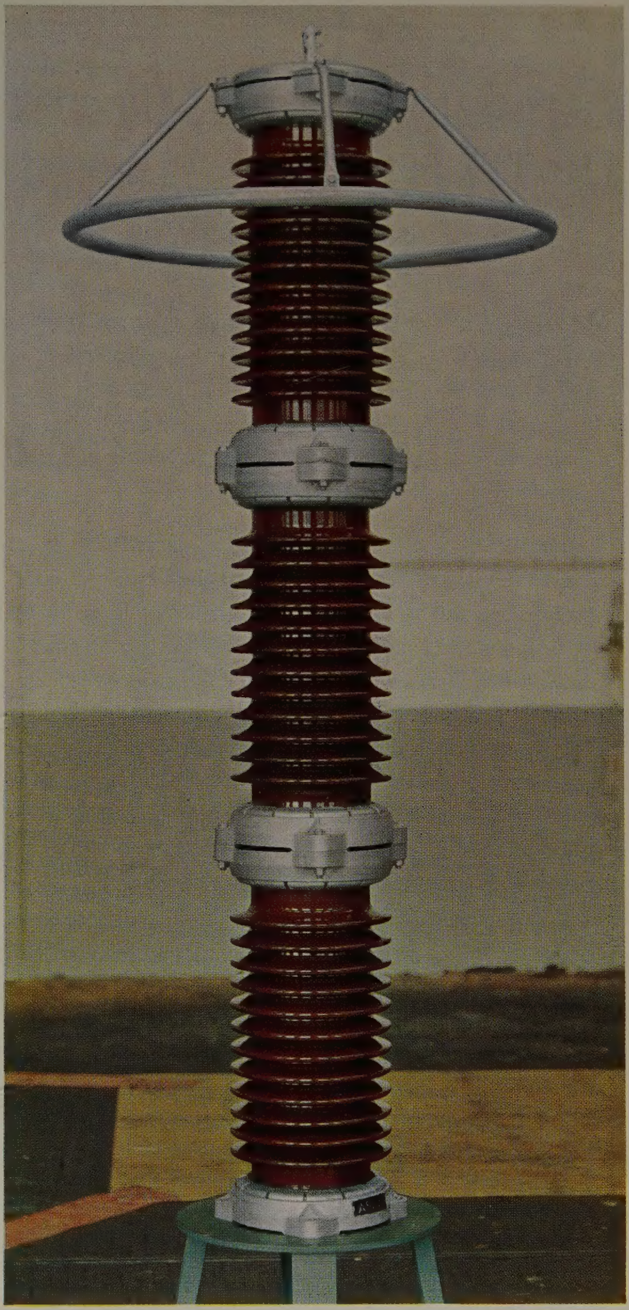


Fig. 5. Complete active-gap arrester, voltage rating 265 kV. (F 930)

CUBICLE-TYPE SWITCHGEAR FOR VOLTAGES UP TO 500 V

Eric Gott, Industrial-plant Division, Västerås

U.D.C. 621.316.344.027
Asea Reg. 586

The principles on which Asea switchgear for voltages up to 500 V is based are described. With a selection of standard elements it is possible to obtain a large number of cubicles for various purposes, such as distribution cubicles, cubicles with motor starters or contactors, and transformer cubicles.

During recent years, the importance of switchgear of cubicle type has increased because of the variety of combinations which are possible not only when distributing electrical energy, but also when distributing in combination with remote control via contactors with appropriate protective devices. Where it was previously necessary to have metal-clad distribution-boards at various points within an installation, it is now possible to concentrate distribution to switchgear in special control-rooms and to obtain an installation which is easier to operate and more functional in many respects. This is particularly the case if the distribution transformer is of the dry type, since it can then be placed in a special cubicle forming a part of the switchgear, thus providing a complete distribution unit. Therefore, in the following, a number of various types of cubicle are dealt with which can all be incorporated in standardised switchgear and which provide many possibilities of combination allowing of a well balanced solution of many installation problems.

The further development of Asea cubicle-type switchgear for medium-voltage distribution purposes [see Asea Journal 28(1955):3, pp. 49–54] is being carried on continually to varying degrees in so far as new designs and new materials become available. During recent years, efforts have been made to fit the results of this development within the framework of standardised dimensions, so that existing installations can be supplemented and extended without major difficulty. At present, Asea are supplying a type of switchgear for a maximum of 500 V with the type designation VMTB, but will soon be able to supply a new type of switchgear designated VMTC containing a number of new components, although, as far as the principle of the design, and the important main dimensions are concerned, it corresponds with type VMTB. Therefore, the following presentation of the switchgear deals not only with the new parts, but also the other parts and with certain basic principles on which the design of the switchgear rests.

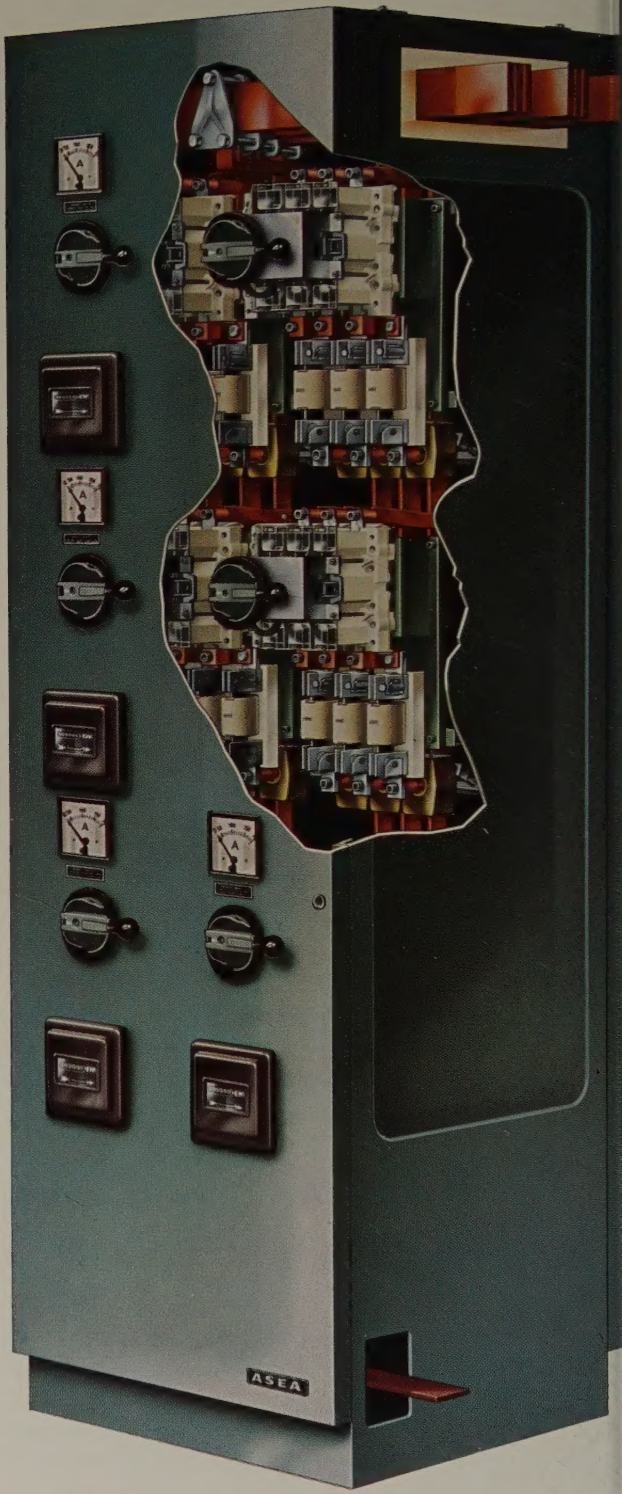
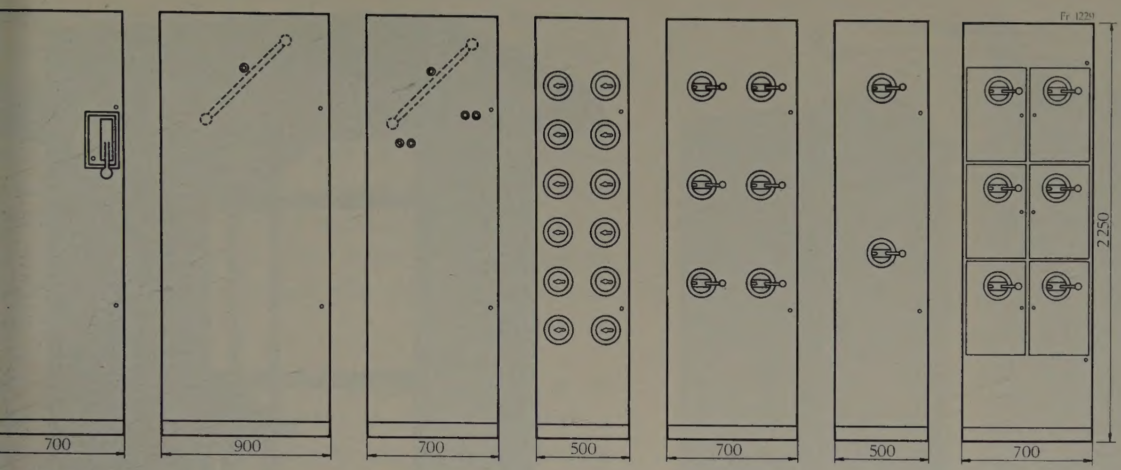
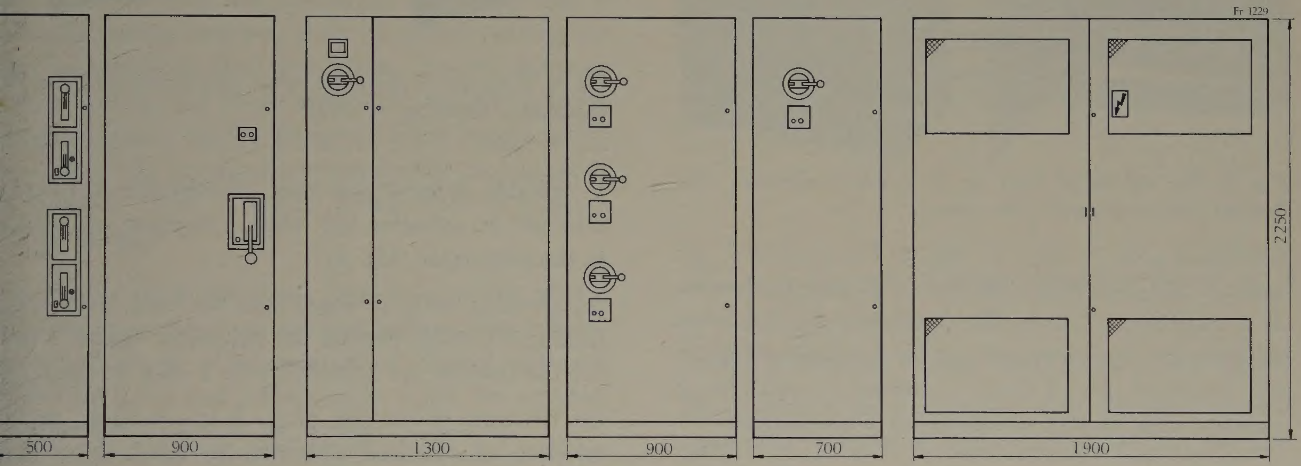


Fig. 1. Distribution cubicle with load switches and fuses Six 400 A units. (F 708)



×1 250–2 000 A 1×3 000 A 3×1 250–2 000 A
solators for incoming supply and sectioning

12×63 A 6×200–400 A 2×630 A 6×200 – 400 A
Load switches with fuses



×600 A 1×3 000 A
ircuit-breakers with built-on
olators

20×25–40 A 3×350 A 1×600 A
Contactor, thermal relay, and load switches and fuses

800 kVA dry-type transformer

ig. 2. Examples of standard cubicles containing various kinds f equipment.

LECTRICAL DATA

he most important data for the switchgear can be ummed up in the following points:

. The switchgear is designed for both alternating current and direct current.

. The maximum rated voltage is 500 V a.c. and 600 V d.c.

. Main busbars and vertical risers can be designed for a maximum of 3,300 A.

. An earthing busbar or a neutral busbar in the case of a solidly earthed system is normally designed for 580 A. Busbars for the operating current can be arranged if desired.

. The main busbar system and its insulators are designed to withstand a maximum surge current of 60–120 kA (peak) depending on the rated current and the width of cubicle. Higher values can be attained if special reinforcing braces are used.

6. The load switches, in combination with fuses, have a rated current of 63–630 A.
7. The isolators have a max. rated current of 3,000 A.
8. The power circuit-breakers have a rated current of 600–3,000 A.
9. The fuses and contactors have a rated current of 10–600 A.

The above values are standard ones, but, naturally, special designs are available on request.

DIMENSIONS

The switchgear, which is built up of a number of standardised units or cubicles, has a height of 2,250 mm. The depth of the cubicle is 670 mm, but when the switchgear is free-standing, a sheet-steel plate is added, increasing the depth by 30 mm. The width of the cubicles varies according to the contents in a standard

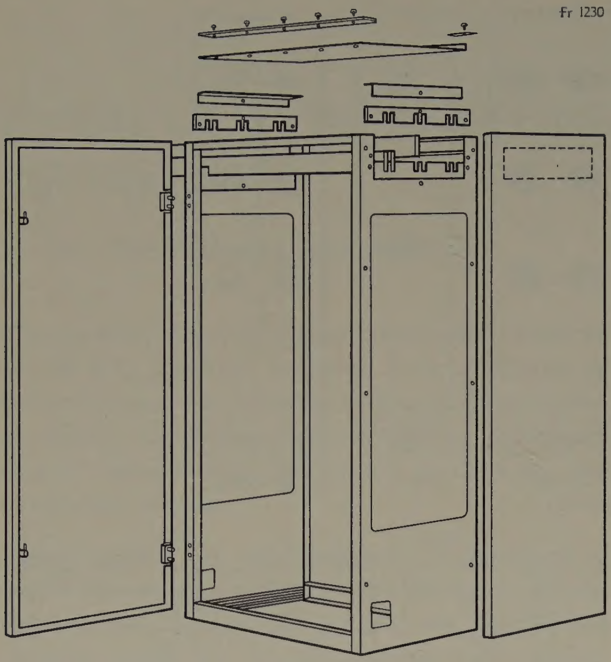


Fig. 3. The cubicle is built up of standard elements. The busbars can be inserted from above.

series of 500, 700, 900, 1,100 and 1,300 mm. In the case of a transformer cubicle, the dimensions are somewhat different for the largest units, as far as height and depth are concerned. Fig. 2 shows a number of examples of standard cubicles with various types of equipment.

DESIGN

One of the guiding principles when designing the switchgear was that each cubicle should be a unit in itself, amongst other reasons, in order to limit any damage caused by arcs to the unit in question. This has been achieved by building up the cubicles of two side plates in the upper parts of which there are bushings for the busbars. This has the additional advantage that, on erection, the busbars can be dropped in from above

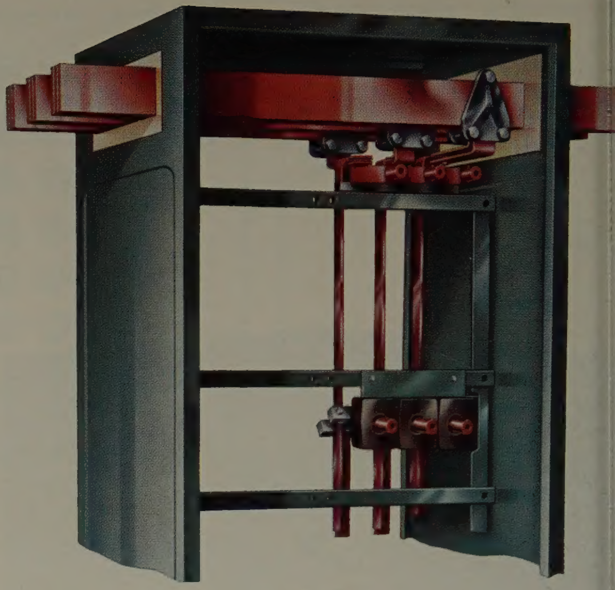


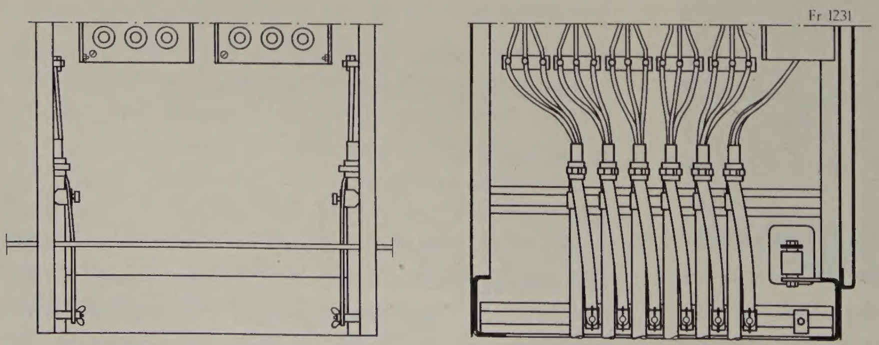
Fig. 4. Close-up of the distribution cubicle in Fig. 1 showin the busbar bushings. (F 709)

in suitable lengths, and that considerable freedom obtained in arranging the other equipment and device in the switchgear (Fig. 3).

All servicing can be arranged from the front, thus alway making it possible to place the switchgear against a wal All the cubicles are provided with a door at the fron

On the basis of the side plates it was possible, with selection of standard elements, to build up a larg number of cubicles for various purposes, such as distr bution cubicles, cubicles containing motor starters an contactors, and cubicles with dry-type transformers. I addition to the side plates, which thus form the frame work of the cubicle construction, the doors and inne sheet-steel items are made of cold-rolled sheet steel.

The bars (or conductors) going down to equipmen below are, as will be seen from Fig. 4, connected to th busbars by means of special clamps in order to provid flexibility, and are, in addition, mutually stayed b



The cubicle, without the lower frame, seen from the front

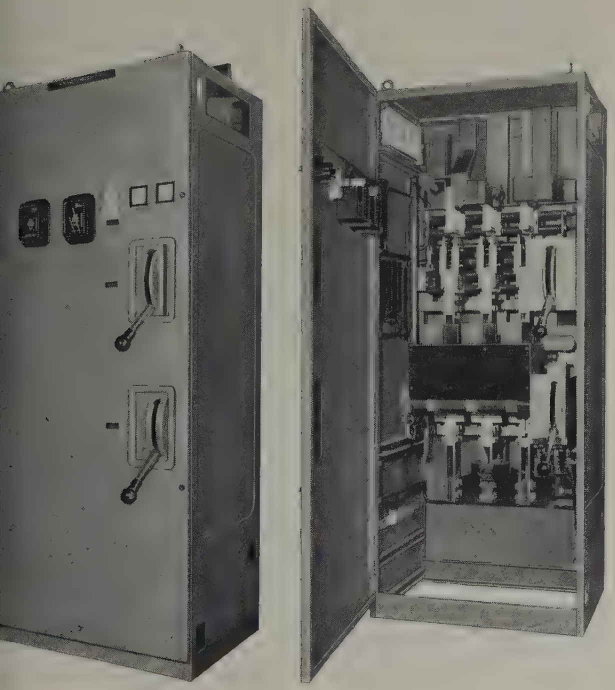
The arrangement of cables on the right-hand side panel with earthing and neutral busbar

Fig. 5. Example of the arrangeme of cables in a cubicle containing twelve 63 A units.

neans of insulator elements in order to withstand the orces arising out of short-circuit currents. Fig. 4 also hows that, for connection to the load-switch units, these ars are provided with end pieces with a tapped hole o arranged that the connection screws can be undone vhen live by means of an insulated tool, whereupon he load-switch unit can be removed. Further, the end ieces are so designed that current transformers of ormal design can be slipped over them and placed on he bars.

t the lower front end of the cubicle there is an perture in the side plate for a neutral bar with a ormal maximum cross-sectional area of 240 mm^2. This an be run through an entire switchgear installation and ll the connections are readily accessible for inspection nd for measuring the insulation level. The bar is ormally mounted on insulators. A special earthing bar an be placed in the same space. Anchor bars are ncorporated in the lower part of the cubicle to which utgoing cables can be fastened. Great emphasis has een placed on leaving adequate space for the connection f outgoing cables. A typical arrangement of cables is hown in Fig. 5.

The steel framework of the cubicle is treated with a ust-inhibiting undercoat and then painted with cellulose arnish, normally of a green colour. Special treatment vith undercoats and surface coats which are resistant o acids and alkalis can be arranged if desired.



ig. 6. Cubicle with hand-operated air-break circuit-breaker vith built-on isolator for 3,000 A. (53821, 53822)

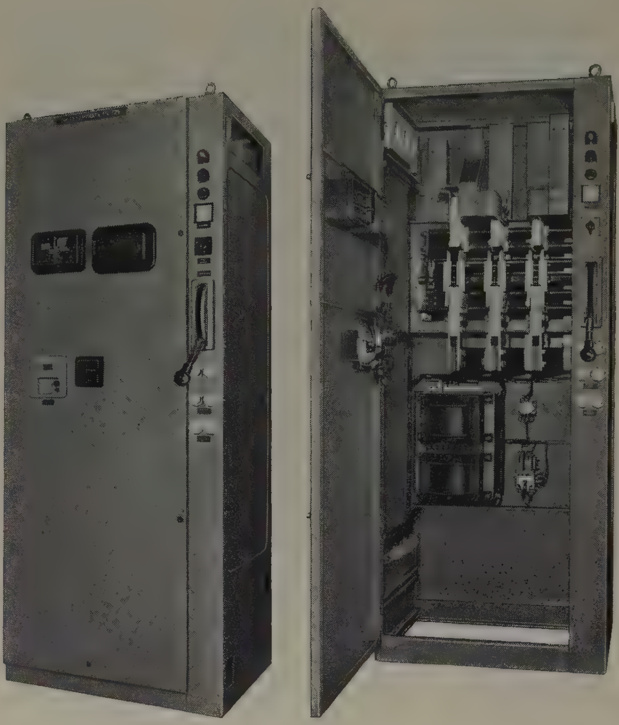


Fig. 7. Cubicle with isolator for 3,000 A and a transformer for the operating current. (53825, 53826)

CUBICLES WITH LOAD SWITCHES AND FUSES

These cubicles are standardised with reference to rated current and number of load-switch units. Both the load switch and the fuse holders are mounted on a common sheet-steel plate and have the type designation AESA.

The load switches, which are available with rated currents of 63, 200, 400 and 630 A, are of the same type as those used in the new enclosed system of type GZ.

The load switches are designed with manual, independent operation both for opening and closing, and can, with their appropriate fuses in series, be closed against a short-circuit without danger or damage. The breaking capacity of the load switches is very good, since, in addition to the fact that they fulfil the requirements of VDE 0660/12.52 for load switches, they can, from a rated current of 200 A and upwards, interrupt at least 2.5–3 times the rated current at P.F. = 0.4.

The load switch is operated by means of a permanently fixed handle with a rotating movement which is located immediately in front of the switch and is set in the door. Fig. 1 shows a normal distribution cubicle. In front of the fuses, a space has been left for instruments flush-mounted in the door with a normal size of 96×96 and 72×72 mm, and meters.

The spacing of the load switch units inside the cubicle is such that there is adequate distance between them. If, however, in spite of this, there is any desire to separate

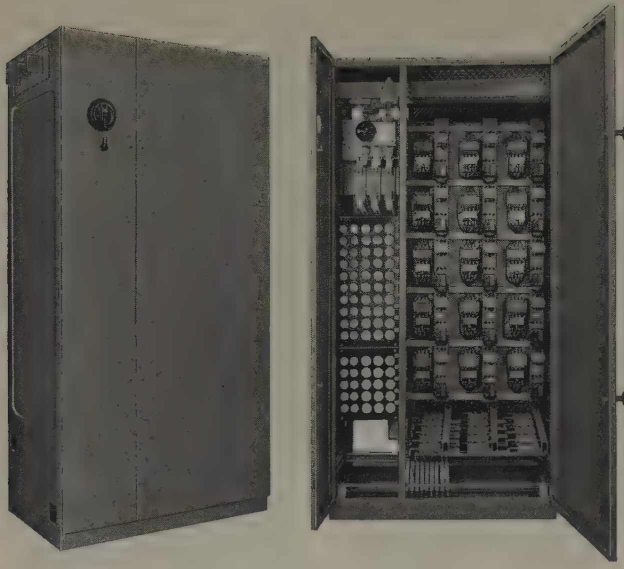


Fig. 8. Cubicle with 15 motor-starter units for 25 A. The conductors run in special ducts. (56496, 56499)

the various units to an even greater extent, this can readily be arranged in the case of units containing blade fuses by means of fixed horizontal screens between the units, and by setting up hinged screens in front of the fuses. In order to separate the units still more, the cubicle door can, if desired, be designed with individual doors for each unit. In the case of load-switch units with 63 A D-fuses (screw-plug cartridge fuses), the fuse holders and appropriate connections are, in the basic design, protected by means of a fixed screen.

CUBICLES WITH CIRCUIT-BREAKERS

The air-break circuit-breaker which is used in these cubicles is of Asea type ALC, which, in the truck-type model and with built-on interlocked isolator, has the type designation ALAC. The appearance of the cubicle can be seen from Fig. 6. The circuit-breakers can be provided with hand or motor operating gear.

These cubicles for circuit-breakers can very easily be supplemented with current transformers, thermal relays, etc. in order serve as motor-starter cubicles.

CUBICLES WITH ISOLATORS

In the case of switchgear of this kind, all the isolators concerned are of Asea type ANC for rated currents of up to 3,000 A. The largest type is operated by a crank while the smaller ones have handles of the same design as on the air-break circuit-breakers. A normal isolator cubicle is shown in Fig. 7.

ISOLATOR CUBICLES FOR SECTIONING THE BUSBAR

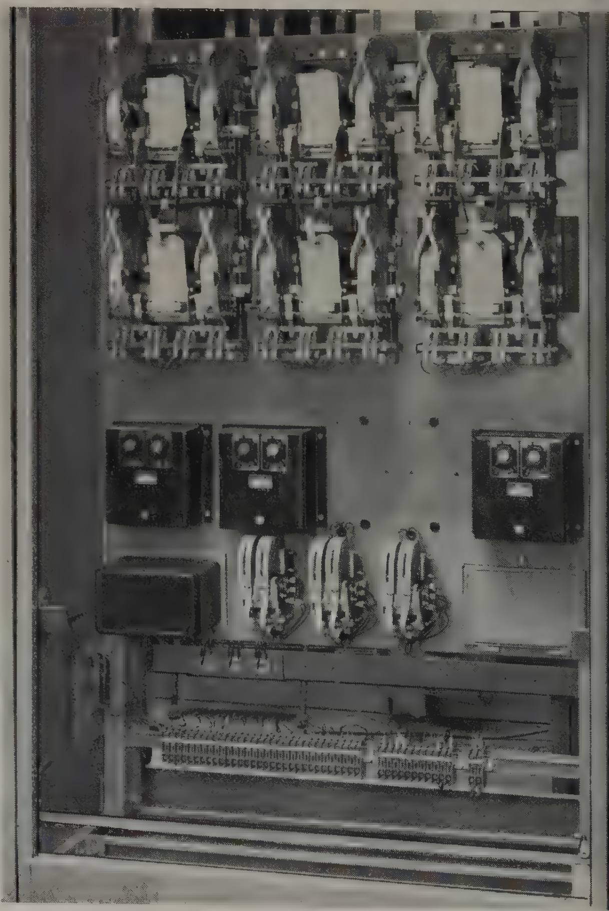
The isolator is of Asea type AND which is of the sam design as type ANC, but has a somewhat differe operating device with a removable operating handle.

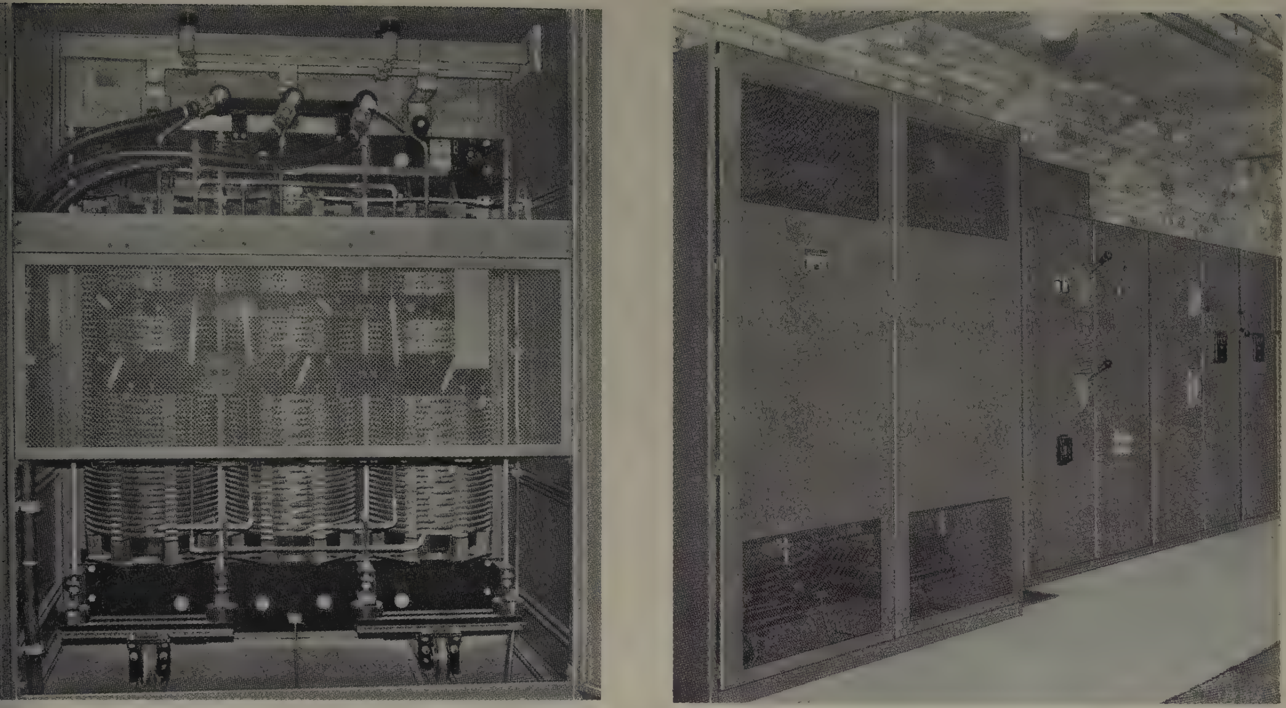
When the isolator is mounted horizontally with th poles in line with the busbar, sufficient space is left f the cubicle readily to be supplemented with, for e ample, more isolators or outgoing load-switch units.

CONTACTOR CUBICLES

Since in most cases when a switchgear installation provided with contactor cubicles they are usually f contactors in motor circuits, development work in th field, which is rich in variations, has mainly been co centrated on motor-starter circuits using contactors fro 10 up to 600 A, in other words, Asea contactors o types EF and EA. Except in the case of the higher rate currents, the equipment consists mainly of:

Fig. 9. Close-up of a contactor cubicle of modified form f special industrial equipment. The conductors run at th back of the hinged steel plate on which the control equip ment is mounted. (53827)





ig. 10. *Cubicle with 1,500 kVA dry-type transformer. The ansformer is withdrawable. To the right, the transformer ubicle is shown in a switchgear installation. (55225, 55223)*

. Common to the whole cubicle:
Load switch with fuses

. For each outgoing unit:
Main fuses
Main contactor
Thermal over-current relay
Auxiliary contactors, if any, max. 2
Current transformers, if any
Operating fuses
Terminal devices
Pushbuttons, change-over switches, instruments, etc., if any

the case of the higher rated currents, the load switch ith fuses is not common to the entire cubicle, but there one for each individual outgoing unit. A cubicle ontaining fifteen 25 A motor-starter units is shown in g. 8, but the type of cubicle in question can be de-gned with twenty units. Instead of contactors rated at 5 A, contactors rated at 40 A can be inserted. Natu-lly, other combinations to satisfy special requirements e available.

hen these cubicles were designed, attempts were ade, in spite of the concentration of equipment, to ake all the items readily accessible, to be able to ange a piece of equipment while the rest of the uipment was live, to lay out the wiring in such a way as to make it accessible, but neat, and to make the design as open as possible in order to facilitate inspection.

It should be noted that in the cubicles for motor-starter units with rated currents of 25 (40) A the fuses are concentrated in a fuse-board below the load-switch fuse, common to the entire cubicle, thus ensuring short lengths of conductors between these, with a resultant increase in short-circuit safety. An additional advantage of this arrangement is that the separate space for the fuse-board, which is screened from the rest of the cubicle, can, if desired, be made accessible to other employees than electricians, while the rest of the space in the cubicle is kept under lock and key.

A somewhat modified form of contactor cubicle has been developed for special industrial equipments and can have a varying complement of contactors and control equipment, mounted on a plate of sheet steel hinged around its lower fixing point (Fig. 9). In this way, after the connections to the load switch and fuses above have been undone, the plate can be tipped forward so that its rear becomes accessible. The lower cable connections need not be touched. To some extent, the design may be said to substitute the truck-type design and it is thus possible to replace all the control equipment of any cubicle.

CUBICLES WITH GROUPS OF FUSES

Cubicles have also been developed for groups of D-fuses (screw-plug cartridge fuses) fed from a common load switch with a main fuse.

CUBICLES WITH DRY-TYPE TRANSFORMERS

It is natural to place a transformer next to the distribution switchgear it is to serve. Dry-type transformers can, if the atmosphere in the premises permits it, be placed in a cubicle in the switchgear since, as distinct from oil-insulated transformers, no fire-protection precautions need be taken. There are switchgear cubicles available for the standard series of dry-type transformers from 200 to 1,500 kVA, of which one for 1,500 kVA is shown in Fig. 10. The transformer itself is provided with wheels and can therefore be withdrawn from the cubicle, if necessary. Busbars are arranged in the top the cubicle in the same way as in the other cubicles.

CUBICLES OF SPECIAL DESIGN

The great flexibility, which is a distinctive feature this type of switchgear, also allows of cubicles of speci design in addition to the series of standard cubicl already described. Examples of these special designs a generator and distribution cubicles for ships, where th requirements are somewhat different from those applyin to normal installations on land, but where, in spite o this, standard elements are used to a very large exten

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INERT-GAS TUNGSTEN ARC WELDING OF ALUMINIUM AND ITS ALLOYS

Gunnar Bengtsson, Aseasvets, Stockholm

U.D.C. 621.791
Asea Reg. 204

An account is given of the origin and influence of the d.c. component when employing inert-gas tungsten arc welding with argon and the requirements made on the welding equipment. The specially designed arc welding sets are briefly described.

When welding aluminium, it is the general practice to utilise inert-gas tungsten arc welding and inert-gas metal arc welding, the former being most widespread and first adopted during the early 1940's. This method calls for welding equipments with special requirements, and this resulted in a new type of arc welding set being developed by Aseasvets, possessing suitable characteristics for this welding system and incorporating designs which have been partly patented.

This development and design work was completed in 1949, and the first production arc welding sets of this special design were put on the market in 1950. Right from the beginning of the adoption of this method in Sweden, Aseasvets were thus able to furnish the specially designed arc welding sets required to achieve perfect results when welding aluminium.

The inert-gas tungsten arc welding is standard practice when welding sheet with thicknesses ranging from a few tenths of a mm up to 10–15 mm, but it may also be utilised for thicker material. Welding is performed with alternating current.

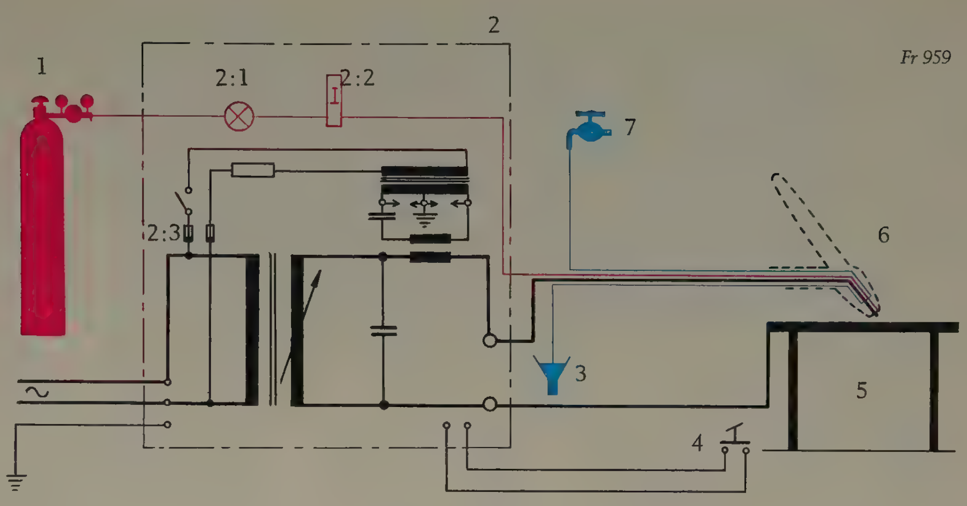
The inert-gas metal arc welding is also used for shee thicknesses from some mm and upwards, where th filler metal constitutes the electrode which is fed fron the electrode holder at a certain speed. Welding is per formed in this case with direct current. This metho will not be treated, however, in this connection.

INERT-GAS TUNGSTEN ARC WELDING

When welding aluminium by means of the inert-ga tungsten arc welding method, an a.c. arc is utilised this being drawn between an electrode of tungsten an the workpiece. The arc burns in an atmosphere of th inert-gas argon, which flows out around the tungste electrode forming a ring. The electrode is inserted i an electrode holder and fully protected. The seat of th electrode is usually cooled with water. Welding curren is supplied through a water-cooled welding cable, an the cooling water as well as the argon are fed to th electrode holder through hoses.

The welding voltage, which is superimposed with high-frequency voltage, is supplied from an arc weldin set. This set also incorporates the gas equipment, whic comprises a flow meter and automatic equipment fo protecting the electrode tip during the cooling-dow period by maintaining the flow of argon. The set ma also incorporate other equipment for special application

1 Argon gas cylinder
2 Special transformer (type ZTLH)
:1 Electromagnetic gas valve
:2 Gas meter
:3 Contactor
3 Cooling-water outlet
4 Foot-operated switch
5 Working table
6 Electrode holder
7 Cooling water



ig. 1. Elementary diagram
or inert-gas tungsten arc
elding with special trans-
ormer of type ZTLH.

schematic diagram of an arc welding set for inert-gas ungsten arc welding is shown in Fig. 1. The control ircuits for the foot-operated switch, gas valve, high-requency equipment, etc., have not been included, nor he special arrangements required for balancing the elding current due to the rectifying action in the arc. Vhen this welding method was first applied in the 940's, standard arc welding transformers were utilised, hese being supplemented by a high-frequency generator et up adjacent to the welding transformer. This design ad several obvious disadvantages, of which the most nportant are as follows:

The purifying action of the arc on the metallic oxides is low, and thus there is a risk of impure weld metal being obtained. The feeding of filler metal is complicated and it is difficult to keep the fusion penetration under control and prevent excessive penetration beads.

The transformer is subjected to a greater load than normal due to the core being magnetised with d.c. by the unbalanced welding current.

The connection of the equipment will be tedious since several components have to be connected up at the welding site (transformer, high-frequency unit, gas valve, gas meter and, possibly, relay protection for the cooling water).

The equipment will be spread out over a large area and thus there is an increasing danger of radio interference from the high-frequency generator. The measures taken to prevent this will be rendered more difficult.

he difficulties mentioned in points C and D were elatively easy to overcome, but those in points A and led to an investigation being made of the arc charac-eristics and current conditions with the inert-gas tung-en arc welding method utilising a.c., particularly when welding aluminium alloys. These investigations were carried out by Aseasvets mainly at the end of the 1940's, and resulted after a very short time in the appearance on the market of a suitable type of set for this welding system, incorporating a new form of circuitry, which has been partly patented.

Origin of the d.c. component

A decisive factor influencing the special requirements made on such an arc welding set is the difference in arc voltage for positive and negative polarity on the electrode relative to the workpiece. This difference in the arc voltage is associated with the asymmetrical arrangement of the electrode system, such as difference in material, temperature and electrical flux lines at the base of the arc. Both the arc voltage and the striking voltage will be higher for current flowing from the electrode to the material (positive current direction) than for the opposite direction of flow.

Owing to the higher arc voltage, the current in the corresponding phase positions will be lower in the positive direction than in the negative one, and this difference represents a superimposed direct current in the negative direction.

The consequences will be more serious, however, in that the positive half-waves require a higher striking voltage than the negative ones. Furthermore, during the positive half-cycle the arcs will be extinguished more rapidly when the arc voltage becomes too low.

The delay in striking is counteracted by using a special striking impulse, consisting mainly of the above-mentioned high-frequency voltage. Despite these measures, the striking of the arc during the positive half-cycles cannot be made to take place equally rapidly as during the negative half-cycles. If the electrode is hot, the arc strikes during the negative half-cycles as soon as the voltage exceeds the necessary arc voltage, even if a special striking impulse is not applied.

The falling voltage-current characteristic is achieved in a standard arc welding transformer intended for metal arc welding by means of a built-in inductance. This inductance promotes the development of transient switching phenomena, which are repeated each cycle and cause the difference in size of the current to increase during the positive and negative half-cycles. The following will then take place.

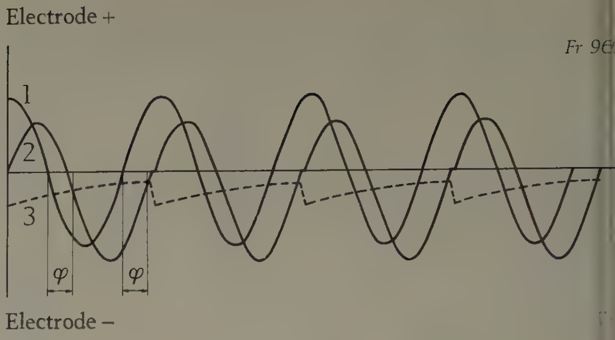
When the arc is struck, the electrode being positive, the current start is slightly delayed relative to the normal point of the current wave passing the zero-value at the power factor in question for the welding current circuit. A negative direct current will thus be superimposed on the alternating current, see Fig. 2. Due to the d.c. component, the positive current half-wave will pass the zero-value before the normal time with regard to the phase angle φ. Since the arc during the negative half-cycles strikes for a hot electrode immediately when the positive arc has been extinguished, the current will now start to flow before the angle φ after the voltage wave has passed its zero-value. The superimposed direct current flows in the same direction as the alternating current and constitutes a direct continuation of the d.c. component from the previous positive half-wave.

During the negative half-cycle the current will cause the arc to remain ignited past the angle φ and thus delay the striking during the subsequent positive half-cycle. Yet further time is required for the high-frequency striking impulses to ionise the path of the arc so that the arc can be struck again during the positive half-cycles, after which the same phenomena are repeated once more.

If the striking during the positive half-cycle is delayed more than usual, this will result in the d.c. component increasing both during the initial cycle and the subsequent one. Such a delay can arise when the welding is performed with an insufficient heating zone, or due to an arc of insufficient length (less heat is applied to the area to be welded when the arc is short), unsatisfactory surface purity of the workpiece and filler material, loss of high-frequency energy due to unsuitably placed or too long welding cable, etc.

When a conventional welding transformer is used, the welding current will thus contain a considerable direct current. Measurements show that the d.c. component amounts to 40 to 50 per cent of the r.m.s. value of the welding current. It should be noted that, when measuring the r.m.s. value of the current, an instrument giving a direct r.m.s. value reading must be used and that this instrument must not be connected across a current transformer.

An oscillogram is shown in Fig. 3 which records welding with a conventional arc welding transformer (type



1 Voltage
2 Welding current
3 D.C. component

Fig. 2. Welding current as a function of time for inert-g tungsten arc welding with conventional arc welding tran former.

TLM 220). The r.m.s. value of the welding current wa 128 A, and the superimposed d.c. component was foun to be 49 A, i.e., 38 per cent. The oscillogram in Fig. was recorded with a special transformer (type ZTL 500). Here the r.m.s. value of the welding current 128 A and the d.c. component was found to be 15 i.e., 12 per cent.

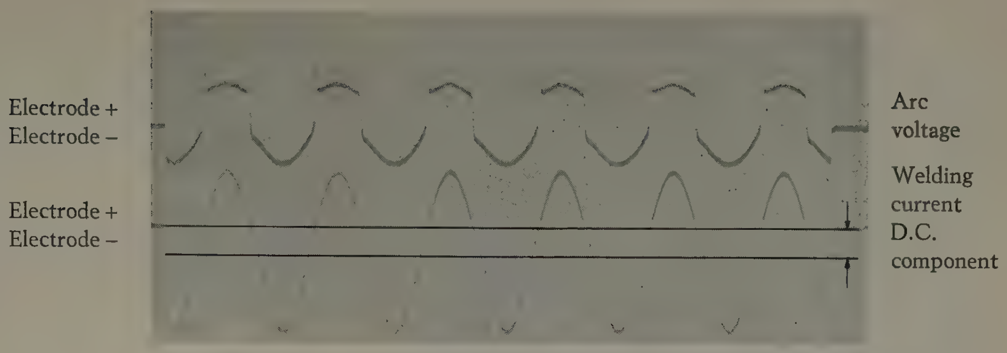
It is apparent from both these oscillograms that the ar is struck at a low voltage when the electrode forms th cathode. When the workpiece forms the cathode, th arc is not struck until the voltage considerably excee the arc voltage and then only with the aid of the high frequency voltage.

Importance of the d.c. component

After having clarified the origin of the direct current, remains to give an account of its influence on the equipment and on the welding results.

The direct current in the welding circuit magnetises th core of the welding transformer with d.c., which result in the primary winding carrying a greatly deforme alternating current. The conventional arc welding transformer will absorb a far higher current from the network with inert-gas tungsten welding than with meta arc welding for which it is designed. At the time of thes investigations, the welding current available for inert-ga tungsten arc welding was stated to be about 70 per cen of the transformer current rating. Blown fuses and eve burnt transformers were by no means an unusual occurrence.

The consequences of the d.c. magnetisation of the co will become more serious, the higher the flux densit in the core. If, furthermore, the quality of the transformer sheet is such that its saturation lies only slightl above the maximum flux density during service, th primary current increases greatly and the transforme characteristics deteriorate. Great care must therefo



g. 3. Inert-gas tungsten c welding with conventio- l arc welding transformer f type TLM 220). The n.s. value of the welding rrent was 128 A and the c. component 49 A, i.e., per cent. (Z 10958)

e observed with certain welding transformers where e core material is very much exploited. These are sually even less applicable to inert-gas tungsten arc elding than their predecessors.

he influence of the d.c. component on the welding sults is of the utmost importance. During the positive alf-cycle when the workpiece in fact forms the cathode, e metallic oxides on the aluminium surface are dissolved nd eliminated as a result of the rapid movement of the ot concentrated cathode spot around the weld zone nd the bombardment of heavy gas ions. This dissolving the oxides is necessary if the molten pool is to be ble to flow and the filler material to be applied. The eat conveyed to the workpiece is relatively spread out terally but has little influence on the depth.

uring the negative half-cycle the workpiece constitutes e anode and is then struck by a relatively concentrated ream of electrons, which greatly heat up the material ith a comparatively limited diffusion laterally, but ith a good depth effect.

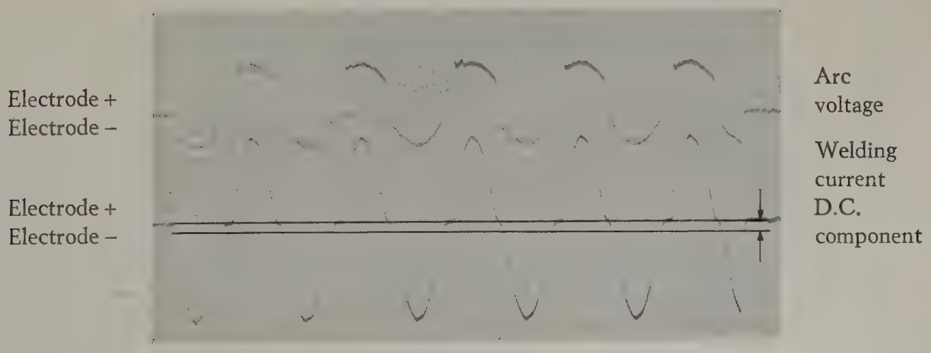
he electrode is heated up most during the positive alf-cycle, i.e., when it is the anode.

he following requirements should be assessed, bearing mind that 1 and 2 and 3 and 4 are to some extent ntitheses of one another.

The dissolving and elimination of the metallic oxides on the joint edges and filler material should be complete.

2. The heating up of the electrode should be kept low to permit the use of the smallest possible electrode diameter without the risk of the formation of droplets at the tip of the electrode.
3. The "pressure" exerted by the arc on the molten material must not be excessive, thereby causing the surface of the melt to become concave.
4. The penetration must not be too little, but should be adapted to the material thickness, type of joint and welding position.

As has already been mentioned, the positive half-waves (the electrode as anode) ensure the purity of the weld, but, at the same time, impart to the electrode a considerable heat surplus. During the negative half-cycles (the workpiece as anode) a considerable penetration is obtained, but if this becomes too great, there is a tendency for the molten material to be forced aside. When using a standard arc welding transformer, where no measures are taken to balance the welding current, the positive half-waves are suppressed and the negative ones magnified due to the already mentioned d.c. component. An arc fed with welding current having a large d.c. component has an inferior purifying effect on the oxides particularly for high-grade welds, but gives a low electrode temperature. The penetration is large and the molten pool narrow, and, furthermore, heat will be applied to the weld during practically only every other half-cycle. The molten material is consequently forced aside with the risk of excessive penetration beads and oxide inclusions.



g. 4. Inert-gas tungsten c welding with special ansformer (of type ZTLH 0). The r.m.s. value of e welding current was 8 A and the d.c. compo- nt 15 A, i.e., 12 per cent. 10958)

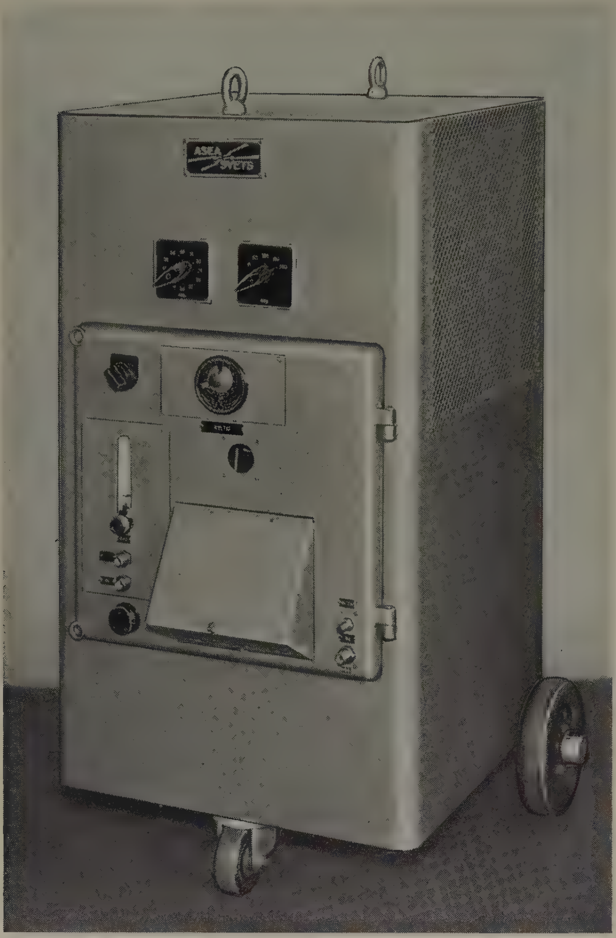


Fig. 5. Inert-gas tungsten arc welding transformer of type ZTLH which yields the desired proportion of direct current for different current settings. (S 61069)

The feeding of the filler material is hindered, since during the melting it has a tendency to become enclosed in a film of oxide and to "be blown away". (An increased flow of argon may nevertheless improve the situation.)

If an arrangement is introduced into the welding circuit for the purpose of suppressing entirely the d.c. component, a balanced welding current will be achieved. This will result in an excellent purifying action on the oxides but also a pronounced development of heat by the electrode, which, in practice, means that a relatively massive tungsten electrode must be used to avoid the formation of droplets on the electrode tip. A large electrode will also lead to an inferior concentration of the arc, which contributes to an increased diffusion and reduced depth of the molten pool. The heat radiation too from the relatively large electrode increases the lateral diffusion of the molten pool. The limited penetration hinders the execution of the welding, especially with increasing material thickness. When welding without any backing bar, the load capacity of the material will be low relative to the size of the molten pool, a thus excessive penetration beads will easily develop.

The ideal welding current should thus be composed an alternating current superimposed with a certai relatively small direct current. The magnitude of tl d.c. component should be suitably adapted to the d mensions of the workpiece. An increasing depth effe is desirable for a thicker material, at the same time the surfaces the oxides of which are to be dissolved a small relative to the volume of the molten materia A "fiercer" arc, i.e., a welding current containing slight more direct current relatively speaking, can thus permitted. When welding thin material, on the oth hand, it is desirable to be able to limit the penetratio and to maintain a high oxide purifying effect.

Experience has shown that the d.c. component shou not exceed 10 per cent of the r.m.s. value of the wel ing current for material thicknesses below 1 mm. F thicknesses above 1 mm a welding current with a d. component of 10–20 per cent is desirable. If a large d.c. component is present, disturbances will arise durin the welding, and the results will be far from satisfactor

Arc welding sets

When selecting a welding transformer for inert-gas tun sten arc welding, it is thus advisable to refrain fro using the conventional arc welding transformer, bot the standard design for metal-arc welding with coate electrodes and the type built together with high-fr quency equipment, gas equipment, etc., called inert-ga tungsten arc welding transformer. These transforme types are not suitable for welding if a high-grade wel is to be achieved.

There are various ways of incorporating arrangemen for suppressing or for completely eliminating the d. component. One method which, in principle, is simp but expensive is to connect up a large capacitance series with the welding current circuit. All direct curren is prevented in an effective manner from developing the welding current circuit, which, according to th above, is not the most ideal solution but better than n measures at all.

The ideal current conditions can be achieved by simp means if the welding transformer is designed for resistive welding current circuit.

The transient currents caused by delayed connectio during the positive half-cycle are damped immediate and do not influence the negative half-cycle. It is th impossible for this latter half-cycle to be magnified. B adjusting the instant of striking for the positive hal cycle with the aid of the high-frequency voltage, it possible to impart to the welding transformer a d.

aracteristic which will yield automatically the desired oportion of direct current at different current settings. direct current of less than 5 per cent cannot be obined, however, and this is not desirable either. The ert-gas tungsten arc welding transformer of type ZTLH 'ig. 5) is based on this principle and patents have een granted for it in various countries. The above inciple has been applied to this type of transformer ıce the end of the 1940's.

rticular care has been devoted to the design of the gh-frequency generator, which is of spark type with ries-connected spark gaps. Since the oscillating circuit the high-frequency generator operates with a comratively high voltage at 50 c/s, special measures must taken to prevent disturbances from affecting the elding current circuit. The Swedish safety regulations r arc welding equipment, which came into force on e 1st April, 1958, contain special stipulations regarding e design of the high-frequency generator. It has nevereless been established that all welding sets of type TLH supplied prior to this date comply fully with ese stipulations.

om the viewpoint of radio interference, the highequency output should be kept as low as possible. has only been found necessary in a few cases out of veral hundred to incorporate specially designed radio terference protection owing to the local conditions. is has mainly applied to such cases where the welding t is used in airfields, radio factories, etc., where parcularly severe requirements are made regarding a low terference level.

e design of the welding set is not, however, the only cisive factor for a good weld, but it is a prerequisite r this.

ther equipment

reat demands are also made on the other equipment well as on the filler material and electrodes. The ost important aspects of these requirements are menoned in the following.

The hoses, connections and valves for the argon should be tight.

Air must be prevented from being sucked into the gas flowing in the electrode holder. Special care should be devoted to the fixing and shape of the gas nozzle.

If the electrode holder is water-cooled, great care must be taken to prevent water from penetrating into the gas ducts. More reliable means than gaskets, rings, etc., should be utilised for separating the gas and cooling water ducts.

4. The cooling of the electrode should be good.
5. All connections and connection fittings in the welding current circuit should be properly designed. When arranging the workpieces on the working table which is connected to the return lead, check that there is good contact with the working table. The low weight of aluminium-alloy workpieces often means that this contact is inadequate. Both parts of the workpiece should have good contact with the return lead (possibly through the working table).
6. The filler wire should have the correct composition, suitable dimensions, low oxide and gas content and be free from organic substances. The wire should not even be handled with bare hands.
7. The argon should be quite free from moisture and have a high degree of purity. Draughts which would disturb the shielding gas should be avoided.
8. The tungsten electrode should have the best possible current-carrying capacity and a high purity. The use of thorium or similar additives should be avoided since they only increase the d.c. component in the welding current and thus counteract the efforts made to suppress this component in the welding set. The tungsten should be homogeneous. The large temperature changes in the electrode must not cause the formation of cracks in this.

It is then up to the workshop and welder to see that the joint surfaces of the workpiece are properly prepared and cleaned of organic substances and oxides. Furthermore, the correct welding current, electrode diameter, gas nozzle and gaz flow are to be selected. The electrode should be centered in the gas nozzle and not be moved out more than a few mm from its outlet. During the welding, the electrode is to be fed with an arc the length of which corresponds roughly to the electrode diameter. When using very thin electrodes, the arc length should be longer than the electrode diameter, but not exceed it by more than about 2 mm. The filler material should be applied in drops and each drop should be allowed to spread out well before the next one is applied. The end of the rod with the filler material should not be unnecessarily removed from the shielding atmosphere around the arc.

CONCLUSION

If it is desired to achieve a high-grade weld in aluminium alloys, it is of the utmost importance that there is access to practical equipment, clean and well prepared workpieces and filler material, argon which is above all dry but also clean, a first-class electrode and, last but not least, well trained welders.

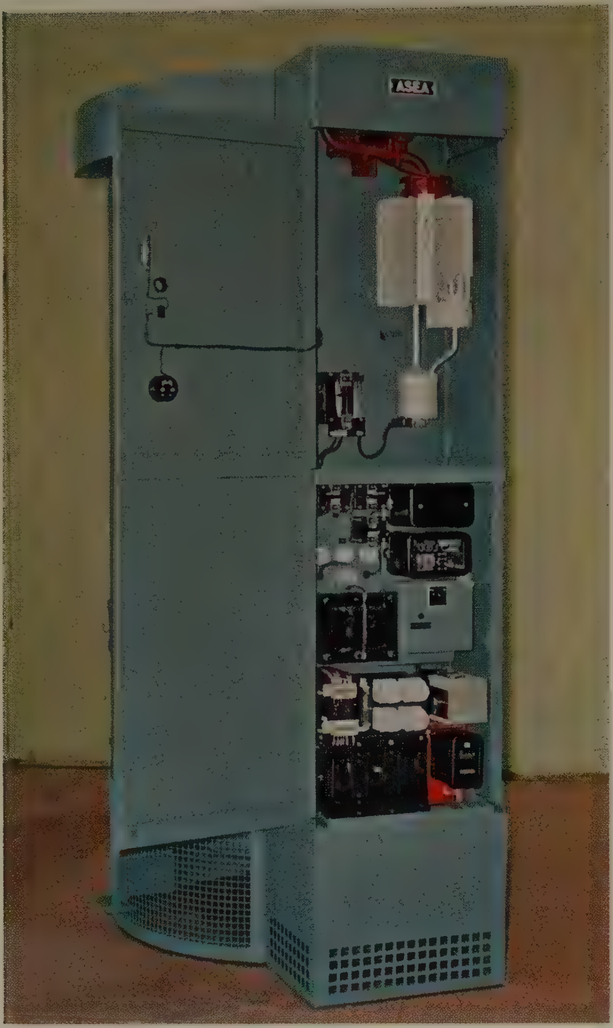


Fig. 1. Industrial design of mercury-arc rectifier. (F 663)

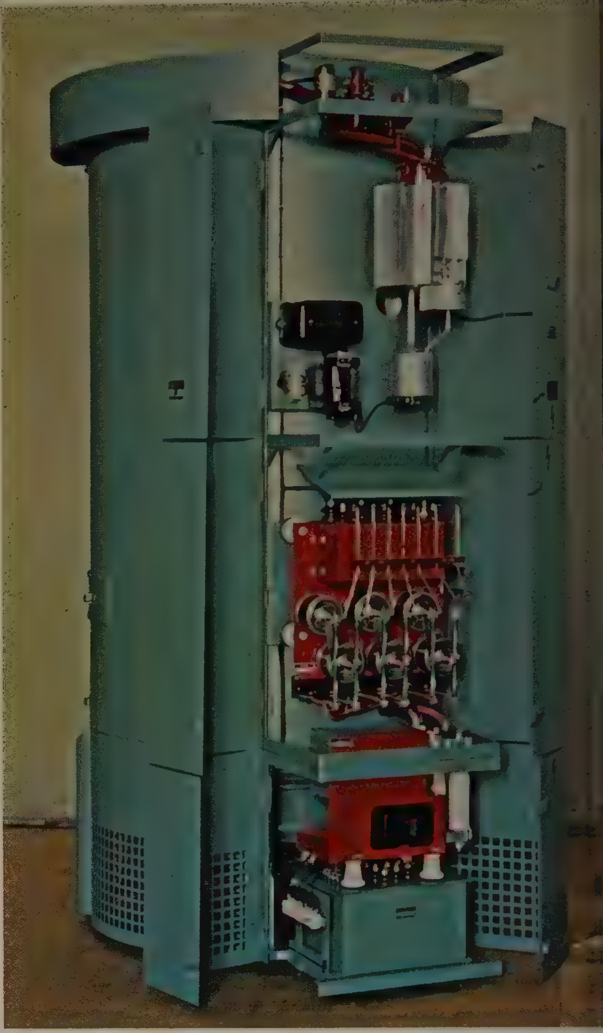


Fig. 2. Mercury-arc rectifier for traction service. (F 777)

NEWS IN BRIEF

MERCURY-ARC RECTIFIER JR(B,C)L 11 FOR INDUSTRIAL PLANTS AND TRACTION SYSTEMS

The Asea mercury-arc rectifier type JR(B,C)L is of six-anode design with a simplified evacuation system. It was originally intended for use in installations where the direct-current voltage was less than 1,500 V and where little or no demands were made on the regulation of the direct voltage by means of grid control. Lighting installations and tramway systems were two typical examples of the application of this earlier mercury-arc rectifier.

The need for higher direct-current voltages for traction systems as well as better control characteristics for industrial motor drives has led, however, to the introduction of three variants of the original design, see Table 1.

The basic appearance of the mercury-arc rectifiers is apparent from the above illustrations. The mercury-arc rectifier itself is enclosed in the rear cylindrical part. The cubicle in the front contains the necessary auxiliary equipment, such as the ignition and excitation devices, starter for the fan motor, fuses for the auxiliary power as well as auxiliary relays for starting, stopping and supervision.

The *industrial design* of rectifier with air cooling is shown in Fig. 1. This rectifier is provided with grid control for both rectification and inversion, and the circuits are designed so that blocking may be obtained in the event of any disturbances. The rectifier has two excitation anodes which are fed with a.c.

Table 2 lists the deliveries and orders in hand as well as the individual rectifier loads. It should be pointed out in this connection that the maximum load varies for the different sets; it lies normally between twice and three times the rated current.

The *traction design* of rectifier is shown in Fig. 2. This mercury-arc rectifier is provided with a grid for non-controlled service and grid blocking for disturba ces. Its excitation anode is fed with c rect current. The most recent sets sup lied for 3,300 V have a rating of 1,5 kW and are designed in accordance wi the stipulations for load class VI A the I.E.C. Standards, i.e., for a load

100 per cent for three hours
150 per cent for two hours
300 per cent for five minutes

The deliveries and orders in hand a listed in Table 3.

Asea Reg.

Table 1. Design forms for mercury-a rectifiers type JR(B,C)L 11.

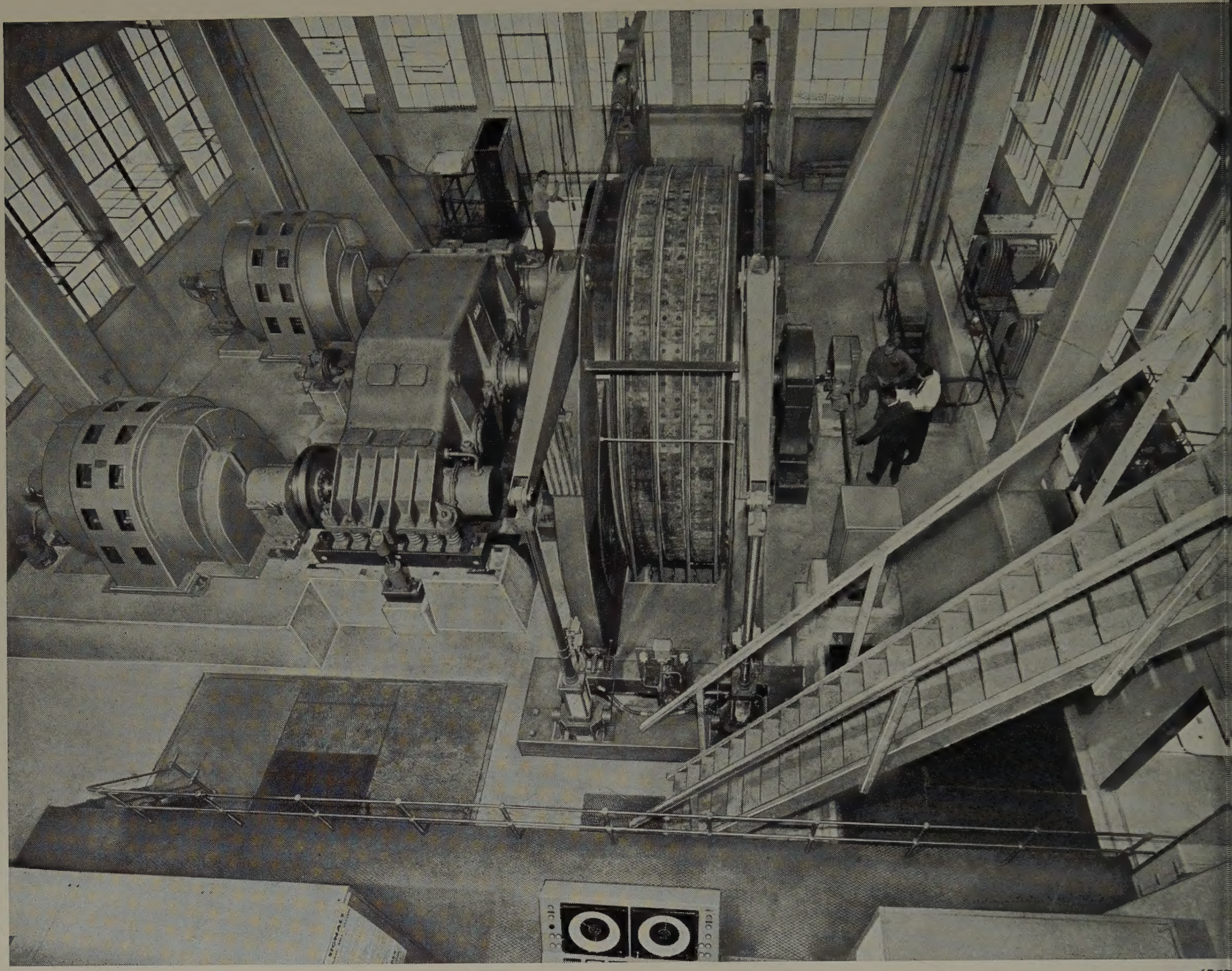
Applications	Max. d.c. voltage V	Coolant
Traction systems	3,300	Air
Industrial plants	1,500	Air
Industrial plants	1,500	Water
Other plants	1,500	Air

le 2. Mercury-arc rectifiers for industrial plants (rolling mills and mine hoists): iveries and orders in hand (Aug., 1961).

omer	No of sets	No. of recti- fiers	Rectifier data Direct current A	D.C. voltage V	Com- mission- ed	Application
leholms AB, Sweden	3	6	1,630	230–600	1957	Continuous combination mill
ahammars Bruks AB, Sweden	2	8	650	± 1,200	1958	Four-high mill } hot-Steckel mill
ahammars Bruks AB, Sweden	4	4	1,320	± 600	1958	Coilers
ahammars Bruks AB, Sweden	1	1	1,000	130	1958	Auxiliary supply
elösunds Järnverks AB, Sweden	2	12	810	± 1,000	1960	Reversing slabbing mill (twin drive)
elösunds Järnverks AB, Sweden	2	12	810	± 1,000	1960	Reversing plate mill (twin drive)
elösunds Järnverks AB, Sweden	1	2	800	± 1,000	1960	Ingot shears
edjebackens Valsverks AB, Sweden	2	4	1,600	185–780	1960	Continuous combination mill
ingesbergsbolaget (TGO), Sweden	1	4	775	± 1,400	1961	Mine hoist
I. Hainaut-Sambre, Belgium	1	6	700	± 1,200	1961	Reversing billet mill
I. Hainaut-Sambre, Belgium	4	17	700	± 1,130		Reversing slabbing mill (twin drive)
mnarfvets Jernverk, Sweden	5	20	812	1,200		Continuous strip mill
mnarfvets Jernverk, Sweden	1	5	733	± 1,200	1960	Reversing structural mill
mnarfvets Jernverk, Sweden	3	9 3	890 500	+ 1,200 – 1,200		Reversing cold-strip mill
rrbottens Järnverks AB, Sweden	1	2	1,200	600–1,000		Planetary mill
rrbottens Järnverks AB, Sweden	1	1	830	360–720		Planishing mill
rrbottens Järnverks AB, Sweden	1	1	1,200	± 720		Mill } reversing skin-pass mill
rrbottens Järnverks AB, Sweden	2	2	960	± 440		Coilers
st Dreifontein G.M. Co. Ltd., South Africa	4	16	515	± 800		Mine hoist
Henricot, Belgium	2	2	1,500	350–650		Continuous wire-rod rolling mill
F, Hofors Bruk, Sweden	1	2	1,000	700		Tube rolling mill
oksenniska, Finland	1	2	1,250	350–630	1961	Continuous small-section mill
ges de Clabecq, Belgium	4	20	730	± 1,200		Reversing plate mill (twin drive)
ges de Clabecq, Belgium	2	4	800	± 1,200		Reversing plate mill, edger stands
ges de Clabecq, Belgium	2	5	380	± 920		Screwdown gear
ges de Clabecq, Belgium	1	1	1,400	460		Auxiliary supply for rolling mill
ristiania Spigerverk, Norway	2	2	1,150	325-750		Continuous combination mill
iolms AB, Sweden	1	2	1,600	600		Continuous hot rolling mill
F, Hofors Bruk, Sweden	1	4	1,600	765		Reversing slabbing mill
ersta Bruks AB, Sweden	6	6	1,150	750		Continuous hot rolling mill

ble 3. Mercury-arc rectifiers for traction systems for high-voltage d.c.: liveries and orders in hand (Aug., 1961).

tomer	No. of sets	No. of recti- fiers	D.C. voltage V	Total power kW	Commissioned
ish State Railways (mobile converter station), Poland	2	4	3,150	6,000	1949
ish State Railways, Poland	18	36	3,150	54,000	1950–1953
ish State Railways, Poland	3	6	3,150	9,000	1953–1957
ish State Railways, Poland	6	12	3,300	18,000	1958–1959
ish State Railways, Poland	29	58	3,300	87,000	1959–1960
ish State Railways, Poland	15	30	3,300	45,000	1960–
.W. Railways, Australia	5	20	1,550	23,000	



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MINE HOISTS FOR SOUTH AFRICA

Asea have supplied recently, or are in the course of manufacturing, 14 mine hoists to various customers in South Africa. All these mine hoists are of the multi-rope, friction-drive type, and the deliveries include both d.c. and a.c. units. Both the Ward-Leonard and the mercury-arc rectifier systems of drive are being used for the d.c. hoists. The photograph shows one of the mine hoists supplied to the Anglo-American Corporation for their new mine Western Deep Levels. This mine hoist, which was commissioned during the autumn of 1960, is of considerable interest for several reasons. The winding depth of 1,860 m (6,100 ft) is a world record, and the mine hoist is the largest induction-motor driven unit manufactured by Asea up to date. The mine hoist is driven by two 3,000 h.p. motors, and the winding speed is as high as 18.5 m/s (60 ft/s).

Other data:

Net load	13.7 tons
Diameter of pulley	5 m (16.4 ft)
Rope diameter	44.5 mm (1.8 in.)

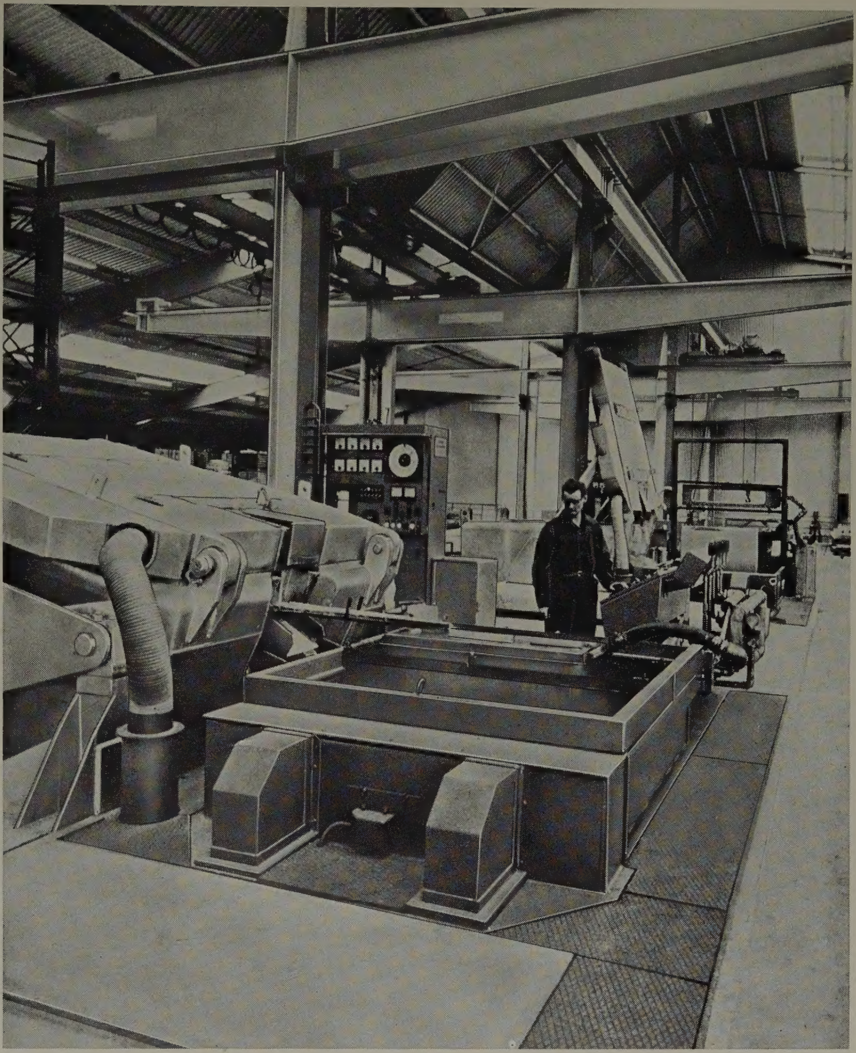
The mine hoist is driven via a ne
patented twin-drive reduction-gear un
which is carried on springs. During
tardation the hoist is electrically brak
by injecting d.c. into the stator windin
of the motors. Special efforts have be
made to divide uniformly the weig
over the four ropes because of the win
ing depth.

Experience up to now seems to indica
that this problem has been solved in
very satisfactory manner by means
rope equalisers on both skips.

Asea Reg.

AINS-FREQUENCY INDUCTION URNACES FOR THE MELTING OF LUMINIUM

ur Asea mains-frequency induction
rnaces of the channel type have re-
ntly been supplied to AB Svenska Me-
lverken for their non-ferrous metal
orks at Finspång. Each furnace has an
put of 500 kW, and the melting capa-
y is 1,500 kg/h at 700°C. The total
arge weight is 9,000 kg, the effective
eight being 6,000 kg. The furnaces are
ed for the continuous melting of alu-
nium for special casting machines. The
ustration shows the upper part of one
the furnaces and casting machine, with
ntrol desk and conrol board in the
ckground. The furnace body and the
draulic tilting gear are located in the
oor below. Asea Reg. 6642

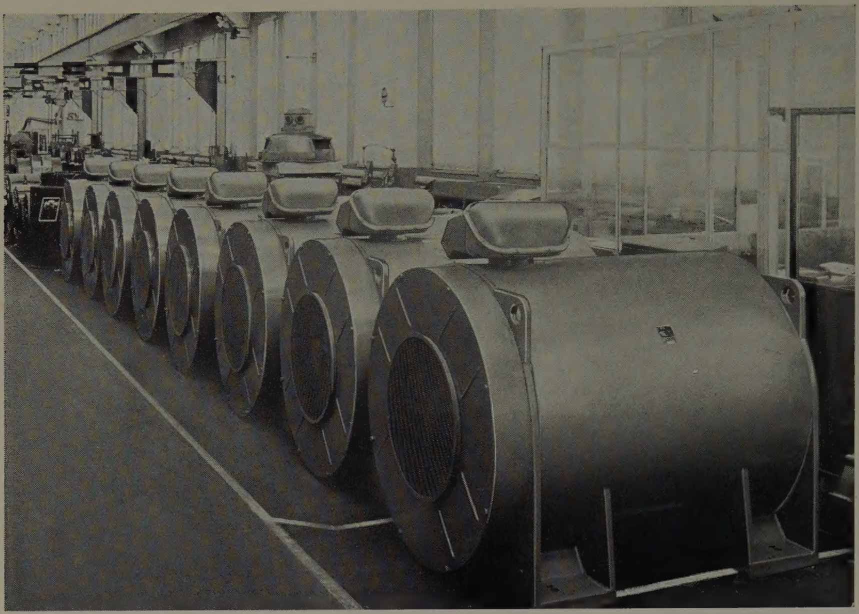


(56183)

HE UTRECHT INDUSTRIAL AIR 1961

he Asea representatives in Holland,
echnisch Verkoopskantoor Groenpol,
nsterdam, took part in the Utrecht In-
strial Fair 1961 which was held be-
een 13th and 22nd March. Two of the
hibits in particular, a surge device of
pe TUA for checking the surge strength
low-voltage installations, and a rectifier
type RIPA 10 for voltage testing, at-
acted much attention. Considerable in-
erest was also taken in the other Asea
oducts on show. The items on display
cluded demonstration equipment with a
mmutator motor provided with motor
erating gear and a pre-setting device, a
odel of a five-ton deck crane, demon-
ation equipment for ring torductors,
pressductors, and for signalling sy-
ems with illuminated mimic diagrams
d relays of type RTOD. A model of a
rbine made by Tubin AB de Laval
ungström, and a three-phase, slip-ring
otor of type MAD 65 were also exhi-
ed. Asea Reg. 9547

(Z 12606)



(55479)

TOTALLY ENCLOSED INDUCTION MOTORS FOR THE U.S.S.R.

The pulp and paper industry in the Soviet Union as well as in many other countries is being considerably expanded and modernised. The adjacent photograph shows a number of large Asea induction motors ready for delivery to the Soviet Union, where they will be used for driving various forms of machinery in pulp and paper mills. These machines are of totally enclosed, fan-cooled design, but unlike small and medium-sized machines the external air is blown by a fan through axial cooling tubes, surrounded by the inner heated air, which is made to circulate by an internal fan in the opposite direction to that of the external air. The machines are designed with squirrel-cage rotors for direct-on-line starting and have the following data: type MBRD 109, 615 h.p., 740 r/m, 50 c/s, 6,000 V.

Asea Reg. 443

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